Australian Acoustical Society
Queensland Division

ACOUSTICS BURSARY

QUEENSLAND SCIENCE CONTEST 2008

The Bursary

The Australian Acoustical Society, Queensland Division will present a **$460.00** bursary for the best project in the field of acoustics; open to students in all Divisions. At the discretion of the judges, this bursary may be split among a number of deserving entries (maximum of five).

The Society

The Australian Acoustical Society is a learned society formed in 1971 to promote and advance the science and practice of acoustics. Members practise or study acoustics in a wide range of areas including architectural acoustics, underwater acoustics, engineering noise and vibration, ultrasonics, environmental and occupational noise management, bioacoustics, hearing and speech physiology, audiology and musical acoustics.

Project Areas

The science of acoustics concerns the study of sound (and hearing) in air, water and other fluids and its interactions with solid materials. Acoustics is a broad field and impinges on many aspects of the physical and biological sciences.

Potential project areas include:

- Architectural acoustics
- Acoustical and vibration transducers
- Bioacoustics
- Engineering noise and vibration control
- Environmental noise and vibration
- Hearing and speech physiology
- Musical acoustics
- Occupational noise and vibration
- Physical acoustics
- Seismology
- Ultrasonics
- Underwater acoustics

A short description of each of the above areas is given below.

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Architectural acoustics: Architectural acoustics involves the study and design of building spaces to determine those attributes which make them acoustically "fit for purpose". For example, to be "fit for purpose" an auditorium, lecture theatre or classroom must provide an environment which allows a person standing in front of the audience to be heard clearly. A bedroom must be quiet enough to allow for sleep. A musical venue must provide satisfactory acoustical conditions for the audience while at the same time limiting the emission of "music noise" into the environment.

Acoustical and vibration transducers: Transducers convert one form of energy into another. The majority of acoustical and vibration transducers convert sound or mechanical vibrations into or from an electrical vibration. A variety of mechanical, electric and hydraulic components and phenomena are used to pick-up or generate sound and vibration. Examples of "pick-up" transducers include microphones, hydrophones, geophones and accelerometers. A loudspeaker is a familiar example of a transducer which converts an electrical signal into sound.

Bioacoustics: Animals use sound (and vibration) to explore their environment and to communicate. Bioacoustics involves the study of the uses and mechanisms of hearing and vocalisation in mammals, birds, reptiles, amphibians, fish, insects, crustaceans, molluscs and other animals. It includes the study of other effects of sound on biological systems. Bioacoustic techniques are used to identify and track individuals or groups of animals and to facilitate study of their interactions with other species and the environment in which they live and move.

Engineering noise and vibration control: This area of engineering applies the science of acoustics to the control of unwanted sound (noise) and mechanical vibrations. Mufflers employ the acoustic effect of a series of passages and chambers to attenuate the major component frequencies of engine noise. Building materials are used to "box" a noise source within an envelope which is more or less opaque to the sound produced within. Sound absorptive materials are used to minimise reverberation and other unwanted effects. Springs are used to isolate vibration from areas which would be sensitive to its effects. "Active" noise and vibration control seeks to cancel noise or vibration by introducing a signal which is equal in amplitude and frequency but opposite in phase to one or more of the major components comprising the disturbance.

Environmental noise and vibration: Industrial, mining and construction processes, road, rail and air transport, sporting and musical activities and home appliances such as air-conditioners, lawnmowers, vacuum cleaners and food blenders, produce noise. While such noise and vibration is often little noticed by those involved in the activity or using the appliance, it may cause intense annoyance to "the neighbours". To ameliorate this unwanted effect a variety of techniques are available ranging from good land use planning which seeks to separate residential areas from noisy industry and transportation, to expensive "after-the-fact" treatments to reduce noise and vibration at source, at the receiver or in between.

Hearing and speech physiology: The physiology behind the human sense of hearing and ability to speak has been the subject of increasingly detailed study since the 1500's. With the advent of the electron microscope, electronic signal processing and the many other technologies now available, our knowledge of the mechanisms of hearing and speech and the processes behind the defects and diseases which affect them, has greatly advanced. This has led to the development of devices and other interventions to assist and protect hearing and speech. In recent times this knowledge has been used in devices such as the "cochlear implant" which allows a partial restoration of hearing in the profoundly deaf.

Musical acoustics: Musical acoustics is the study of the physical, physiological and psychological mechanisms behind music and musical instruments. For example, the physics of vibrating strings, membranes, plates and columns of air is used in different ways in the various families of musical instruments. Similar physics can be identified in the anatomy which supports the human voice. The science of musical acoustics is said to have begun with Pythagoras and other ancient Greeks, who studied the physics of vibrating strings, membranes and air columns. These and other areas of musical acoustics continue to be subjects of active research today.

Occupational noise and vibration: Exposure to loud noise can cause hearing loss. If the noise is loud enough and persists over a long enough period the affected person is rendered deaf. Thus in any occupation where high sound levels are involved, workers must be protected from this effect of their work environment. Similarly a variety of injuries can occur where people are exposed to high levels of vibration over long periods, for example through the hands when manipulating a vibrating tool. Occupational noise and vibration is concerned with managing and minimising such exposure so that the deleterious effects of loud noise and excessive vibration can be avoided.

Physical acoustics: Physical acoustics is concerned with the fundamental properties of sound. Phenomena such as sound transmission, absorption, reflection, refraction, diffraction, interference, scattering and dispersion and the mechanisms of sound propagation through gases, liquids and solids and through the fluid filled pores of rocks and other materials are all relevant to the area. Physical acoustics also includes the interactions of sound with light and other electromagnetic radiation (for example, sonoluminesence) and the use of sound to investigate the structural properties of materials (including at atomic level) and to modify those properties (for example, through the methods of sonochemistry).

Seismology: Seismology is concerned with the study and use of ground vibrations to “sound-out” structures within the earth. Seismological techniques are most commonly used to study the processes behind earthquakes and to prospect for oil and gas. In ancient and medieval periods groundborne noise was used to detect the tunnelling activities of the enemy in siege warfare. In more modern times, artillery detection by use of directional seismic arrays is well advanced. Groundborne noise and vibration from underground trains, other transport and from construction activities, is a topic of current interest in many cities around the globe.

Ultrasonics: Sound with frequencies above around 16 – 20 kHz is undetectable to most people. This is the realm of ultrasonics. Animals such as bats and dolphins use ultrasonic frequencies, to detect prey and avoid obstacles. Prey animals such as moths have evolved the ability to hear ultrasonic frequencies (and in some cases to produce them). Ultrasonic imaging is widely used in medicine. Ultrasonic techniques are used as a means to detect flaws in critical structures, from the welded frames of large mining machines, to prestressed concrete structures and the lightweight composites used in racing cars, yachts, aircraft and wind-turbines. Intense ultrasound can be used to clean and sterilise, to induce chemical reactions and to cut and drill through materials too hard for ordinary mechanical tools to process efficiently.

Underwater acoustics: Sound is a feature of the underwater environment. Most fishes, marine mammals, reptiles and many invertebrates have a well developed sense of hearing and many employ vocalisations to communicate. Whales and dolphins are well known for both for their vocalisations and for their ability to echolocate. Advanced sonar technologies, only begin to emulate the abilities of dolphins and other toothed whales. Sonar was developed to track submarines underwater and related methods are used in a wide variety of applications including depth sounding, profiling of submerged sediments and fish finding. Acoustic methods are widely used to track marine mammals and fish. Underwater acoustic arrays have been deployed under the Global Test Ban Treaty to remotely detect nuclear explosions. Similar systems are used to detect earthquakes and warn of tsunamis.